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Book Review: *Nonequilibrium Statistical Thermodynamics*

Nonequilibrium Statistical Thermodynamics. B. H. Lavenda (John Wiley & Sons, New York, 1985).

According to the title of this book, one would expect to find a discussion of the link between the atomic theory of matter and the laws of macroscopic nonequilibrium thermodynamics, including the methods for calculating relevant nonequilibrium macroscopic quantities such as transport coefficients, as provided by the laws of statistical mechanics. Yet this is not the case. Of course, the main difficulty in covering such a program is that, contrary to equilibrium thermodynamics, its nonequilibrium counterpart is still not well-established. True, for a restricted class of phenomena —roughly speaking, those which occur in the neighborhood of an equilibrium or a steady state—there exist a set of postulates from which one can derive a set of differential equations, in general nonlinear, for the nonequilibrium state variables, containing a number of undetermined parameters which describe the time evolution of the state variables and which, in principle, can be solved if one prescribes the initial and the boundary conditions. The asymptotic in time properties of the solutions should, in principle, be compatible with the properties of the variables in the time-independent state. This theory, known as irreversible thermodynamics, originated essentially from the pioneering work of L. Onsager in the early thirties and in a rather particular form was reformulated in terms of variational principles by Onsager and Machlup in 1953–54. Lavenda's book deals precisely with the Onsager Machlup approach to irreversible processes but not from a molecular point of view. The aim is to provide for the mathematical foundations of this theory using the modern tools of stochastic calculus as they are known to account for the theory of brownian motion. Under the title *The Mathematical Foundations of the Onsager Machlup Approach to Irreversible Processes*, the goals pursued by the author would have been more adequately described. Thus, the processes discussed in the book are Markoffian and primarily Gaussian. They form the core of the material presented in the first four chapters of the book. The

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remaining three chapters are devoted to studying generalizations of the Onsager–Machlup theory, extending it to account for the effects of nonequilibrium Gaussian fluctuations, the formulation of a stochastic analog of Boltzmann's principle, and the behavior of nonequilibrium processes in the limit of small thermal fluctuations.

If envisioned as a book whose purpose is to offer a link between the theory of brownian motion and modern probability theory, this book accomplishes its goals. But by its verytents it will be attractive only to a very restricted audience. Although the author asserts that it is of a nonmathematical character, this deserves a more precise statement. In order to grasp its main achievements and ideas, the reader must command a reasonable familiarity with functional analysis, Wiener measures, stochastic calculus, martingales, path integrals, sigma algebra events, and other similar concepts. Working the material in extenso demands further expertise in such tools of modern probability theory. Proofs of important results are often not offered, although sources for where to find the relevant material for each chapter are included in the bibliographical notes. This will make the book useful and accesible only to those mathematical physicists working in the stochastic foundations of brownian motion. But for those interested in a much more physical approach to irreversible processes the book will be of hardly any use. There are no applications to specific physical systems nor has an effort been made to relate the results of the book to different approaches to nonequilibrium phenomena. In fact, paraphrasing the author himself, it is an account of nonequilibrium statistical thermodynamics as he sees it.

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